Not Just Maintaining
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Smart Energy Design Assistance Center (SEDAC), University of Illinois at Urbana Champaign
Providing effective strategies for public and private buildings in Illinois
Presentation Overview

- Maintenance and Energy
- Utilities and Benchmarking
- Maintenance Programs
- Recommended Tips

**Take away:** Regular Maintenance cost less over the long term.
Maintenance and Building Energy

- ~40-50% of building energy and energy costs are from heating, cooling, fans, and pumps and much higher when adding in lighting.
- Some utility budgets exceed maintenance salaries
- Building Operator is in control of equipment operation, maintenance, and replacement.
Building Energy Example

- Newer School (~200,000 sf) with BAS
- Exhaust Fans weren’t scheduled
- Estimated $7,000 in savings from scheduling off when school was unoccupied.
- Maintenance goes beyond fixing broken equipment. Maintenance is making sure the building systems are running in the best means possible.
Utility Bills

- What are your utility costs or budget?
- The first step to excellent maintenance is knowing what you are using.
Utility Bills

- Usually finance department is in charge of these.
- Don’t be shy to ask for them.
- You can typically download from the internet.
- Why look at these?
## Bill Summary

- **Previous Balance**: $81.21
- **Total Payments - Thank You**: $81.21
- **Amount Due on July 24, 2012**: $81.78

## Service from 5/31/2012 to 7/2/2012 - 32 Days

### Electricity Supply Services

- **Electricity Supply Charge**: 678 kWh X 0.06177 = 41.88
- **Transmission Services Charge**: 678 kWh X 0.00816 = 5.53
- **Purchased Electricity Adjustment**: 3.39

### Delivery Services - ComEd

- **Customer Charge**: 6.86
- **Standard Metering Charge**: 2.76
- **Distribution Facilities Charge**: 678 kWh X 0.02407 = 16.32
- **IL Electricity Distribution Charge**: 678 kWh X 0.00121 = 0.82

### Taxes and Other

- **Smart Meter Program**: 0.02
- **Environmental Cost Recovery Adj**: 678 kWh X 0.00027 = 0.18
- **Energy Efficiency Programs**: 678 kWh X 0.00161 = 1.09
- **Franchise Cost**: $26.19 X 2.64000% = 0.69
- **State Tax**: 2.24

### Total Current Charges

- **Total**: $81.78

(continued on next page)
Utility Bills - Tracking

- Many methods for this
  - Spreadsheet
  - Third Party Software
  - Energy Insights (ComEd)
  - Portfolio Manager
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Utility Bills - Tracking

- One step further is to track weather
- Use Cooling and Heating Degree Days
  - Represent intensity of weather for the day/month/year
  - Available at degreedays.net
    - Use closest weather station
  - Add to spreadsheet
One step further is to track weather using Cooling and Heating Degree Days, which represent the intensity of weather for the day/month/year. Available at degreedays.net, use the closest weather station and add to a spreadsheet.
Utility Bills – Tracking – WHY?

- Begin to compare usage

![Graph showing electricity consumption and cooling degree days over time](image-url)
Utility Bills – Tracking – Benefits

- Comparing current usage to historic usage may help to notice malfunctioning equipment, equipment off schedule, etc.
- Better estimating of utility budgets.
- Verify energy savings projects.
- May want to investigate submetering.
Benchmarking

- Once you know your consumption you can begin to compare to other buildings.

- Compare on a per foot basis.
  - Usually seen as kBtu per square foot per year
  - Can also compare electricity or natural gas use per square foot.

- Know how much room there is to improve
Benchmarking - Tools

- ENERGY STAR’s Target Finder
- Commercial Buildings Energy Consumption Survey (CBECS)
Target Finder

- Uses similar buildings types in the same areas
- Input zip code, facility characteristics, and annual energy consumption
- Receive a score of how you compare
- If your score is higher than 75 you could qualify as an ENERGY STAR building
School Benchmarking

SEDAC Illinois K-12 School Energy Use Intensities

- Electric kBtu/sf
- Gas kBtu/sf
- $/sf

Energy Use Intensity (kBtu/sf/yr)

Energy Cost Intensity ($/sf/yr)
Benchmarking – Motivation

- Comparing current usage to historic usage may help to notice malfunctioning equipment, equipment off schedule.

- Comparing to other buildings can help quantify your potential for energy savings / reduction.
Performance and Maintenance

- Performance of the building is heavily influenced by maintenance.
Various Maintenance Approaches


- **Reactive**
  (“run it until it breaks”) $18/hp
- **Preventative**
  (“follow the schedule”) $13/hp
- **Predictive**
  (“test when to replace”) $9/hp
- **Reliability Centered Maintenance** (hybrid) $6/hp
Cost of Deferred Maintenance

Graphic from Stonegate Property Inspections, LLC
**Maintenance – Where do you stand?**

- **Reactive.** No action or effort is made to maintain equipment as it was originally designed.
  - Disadvantages
    - Increased cost due to down time
    - Increased labor, mostly from overtime
    - Possible secondary damage
    - Inefficient use of staff resources
    - Highest long-term cost
  - Advantages:
    - Low immediate cost
    - Less staff

- **Preventative.** Actions performed based on a predetermined time/use schedule. (Time based maintenance)
  - Disadvantages
    - Catastrophic failures still occur
    - Labor Intensive
    - Sometimes unneeded maintenance
  - Advantages:
    - Increased equipment life
    - Decrease in long-term cost (labor and parts)
    - Energy Savings
    - Better worker morale and safety

- **Predictive.** Measurements taken to detect when to perform maintenance
  - Disadvantages
    - Increased short-term cost in diagnostic equipment
    - Increased short-term cost in staff training
    - Savings potential not readily seen by management
  - Advantages:
    - Increased equipment life
    - Decrease in long-term cost (labor and parts)
    - Energy Savings
    - Better worker morale and safety
    - Estimated 8% to 12% cost savings over preventative

- **Hybrid.** Combination of 3 other approaches but with root cause analysis to solve on going problems.
  - Disadvantages
    - Significant start up cost, training, equipment, etc.
    - Savings potential not readily seen by management
  - Advantages:
    - Most efficient approach
    - Lower cost by reducing unnecessary maintenance
    - Reduced likelihood of sudden failures
    - Usually incorporates root cause analysis

**Comparison of Four Maintenance Programs** (Piotrowski 2001)
O&M Best Practices Guide, Release 3.0
Monthy Gas Usage

- HDD line is a relative indicator of gas use
- Notice pretty good seasonal dependency

Monthy Electricity Usage

- 2008 had summer school
- Some anomalies in 2007
- Fairly high spring and fall baseload
Then, things go crazy.
Economics of Maintenance

- It is estimated that O&M programs targeting energy efficiency can save 5% to 20% on energy bills without significant capital investment (PECI 1999)

- Tune-ups typically translate to energy savings of 5% to 15% (E SOURCE)

- Cost of tune-up (ENERGY STAR)
  - $0.01-$0.10/sf newer bldg
  - $0.10-$0.50/sf older bldg

- US DoE Forrestal Bldg.
  - Steam trap maintenance
  - program saved $250,000/yr
Chiller Tune-Ups = 5% of cooling costs

▪ To maintain efficiency in O&M
  ▪ Maintain economizers
    ▪ Test at least twice a year
    ▪ Damper operation
    ▪ Adjust air temperature sensors
  ▪ Clean and replace air filters
  ▪ Inspect and clean evaporator and condenser coils
  ▪ Measure and correct and refrigerant charge
  ▪ Fix leaks in cabinet and supply ducts
  ▪ Rest condenser water temperature
  ▪ Stage multi-chiller operation to improve part-load performance
  ▪ Other:
    ▪ Raise thermostat settings
    ▪ Reduce run hours
    ▪ Reset chilled water temp
    ▪ Clean evaporator and condenser tubes
    ▪ Minimize use of reheat
    ▪ Don’t cool unused space
Boiler Tune-Ups = 6% SAVINGS

- To maintain efficiency in O&M
  - Develop and implement routine inspection and maintenance program
    - Check steam traps and lines (replace as necessary)
    - Condensate pumps
  - Boiler tune program once per year
  - Insulate piping and central storage tank
  - Blowdown to remove accumulated dissolved solids
    - Excessive blowdown wastes water, energy, and chemicals
  - Water treatment program to prevent scale and corrosion
  - Clean and inspect boiler water and fire tubes
  - Use expansion tank to temper boiler blowdown drainage
  - Install meters on boiler system make-up lines and recirc water loop
  - Consider summer shutdown
Steam Trap Maintenance 15-30% Failed

▪ To maintain efficiency in O&M
  ▪ Test traps and replace as failed
    ▪ Sight method (visually observe steam escaping)
    ▪ Sound method (ultrasonic measuring equipment)
    ▪ Temperature method (thermography) least reliable
    ▪ Automatic diagnostics (self-diagnosing steam trap)
  ▪ Checklist for possible trap failure
    ▪ Abnormally warm boiler room
    ▪ Condensate received venting steam
    ▪ Condensate pump water seal failing prematurely
    ▪ Boiler operating pressure difficult to maintain
    ▪ Vacuum in return lines difficult to maintain
    ▪ Water hammer in steam lines
    ▪ Higher than normal energy bill
    ▪ Inlet and outlet lines to trap nearly the same temperature
Steam Trap Maintenance 15-30% Failed

Steam Leaks

Energy Loss (Millions Btul/yr)

Hole Diameter (inches)

120 psia
110 psia
100 psia
90 psia
80 psia
70 psia
60 psia
50 psia
40 psia
30 psia
25 psia
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